june, 1961

nlgi spokesman

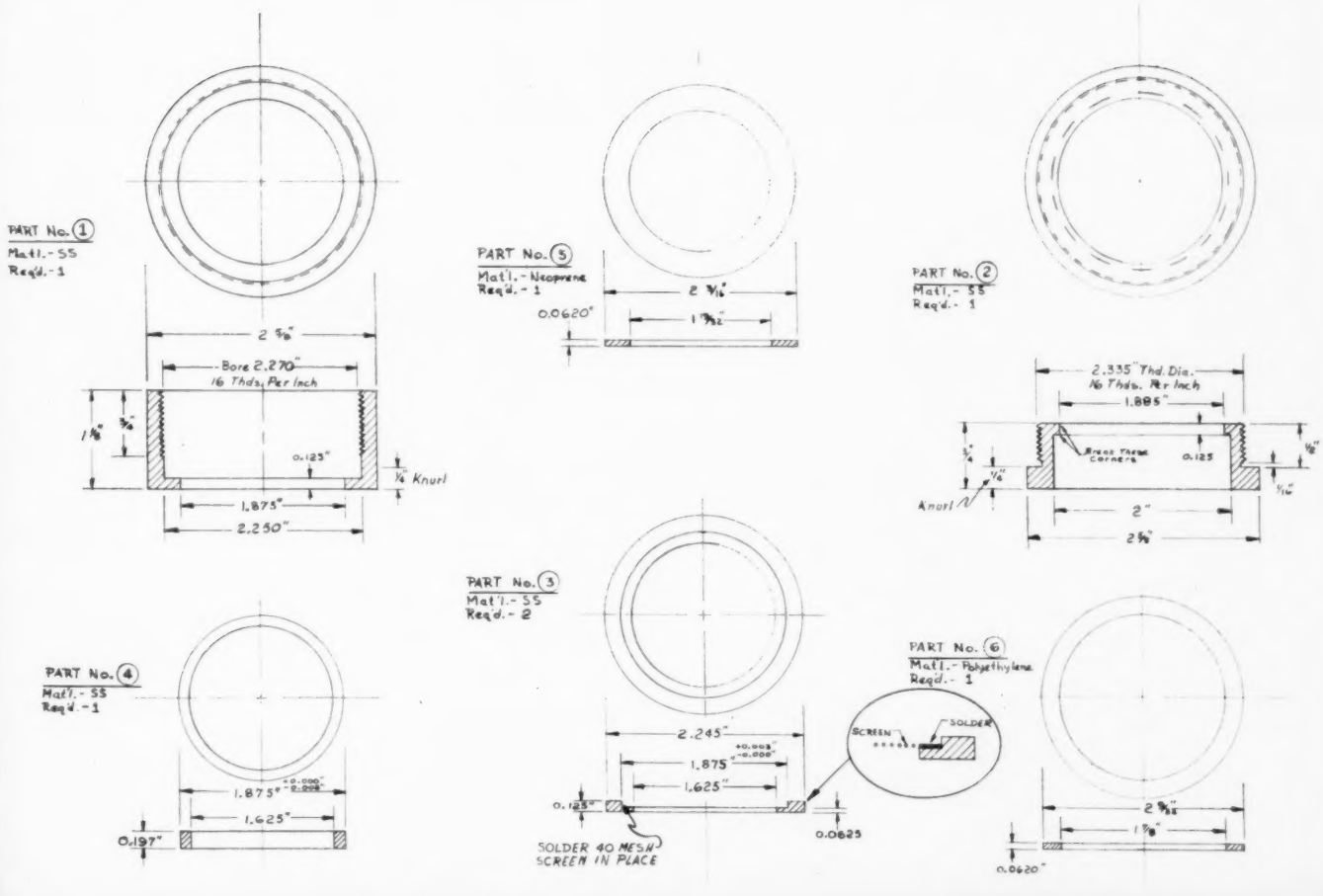
journal of the national lubricating grease institute

New Grease Plant Layout

By M. E. ERWIN and J. C. GEBHART

Permeability of Lubricating Greases

By A. W. SISKO and L. C. BRUNSTRUM



CLIMAX MOLYBDENUM

Molysulfide® News Digest

CLIMAX MOLYBDENUM COMPANY, a division of American Metal Climax, Inc., 1270 Avenue of the Americas, New York 20, N.Y.

RECENT TEST SHOWS MORE PROOF OF MoS_2's LOAD-CARRYING ABILITY

Grease Compounders Take Hard Look At Paste Type Concentrates

In a recent issue of NLGI SPOKESMAN, a prominent lubrication authority warns that in the future an increasing number of the newer machines will be greased "for life"—or for long lubrication intervals. He also says that as the industrial pace quickens and wages go up, it will be more economical to use more expensive grease and reduce lubrication frequency.

That's why grease compounders and blenders are looking into every possible way to maintain and increase their profit levels.

High on investigation priority lists are the paste type concentrates. These concentrates contain solid lubricants. Molysulfide concentrates can be applied by grease guns or by brushing, and will stand up at temperatures as low as –100 F. and peaks as high as +500 F.

Concentrate users include a fast spreading number of industries. Major manufacturers in the automotive industry use paste type Molysulfide concentrates for pre-assembly lubrication of splines, cams, etc.

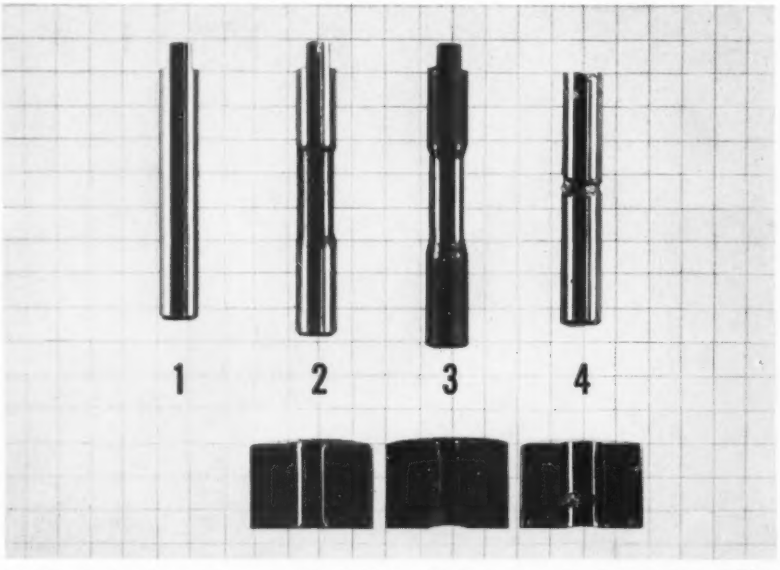
The aviation and missile industry is using an increasing amount to overcome low-temperature problems in servo-mechanisms, bearings and gears.

General industry is applying them, not only on metals exposed to continuous high temperatures, but also on plastic bearings, machine tool ways, press fittings and other moving parts where long lubricant life and high load carrying capacity is needed.

Much remains to be learned about the full potentialities of paste type concentrates but all signs indicate they are one of the answers to lubrication problems of the future.

When writing, refer to CL-110

From the German laboratory of Alpha Molykote Corporation comes new proof of Molysulfide's ability to resist galling and seizing at pressures beyond the yield point of most metals. Previous tests have shown that Molysulfide provides positive protection up to 475,000 psi. In this Alman Wieland test, similar to the Falex test, a ¼-inch pin actually extruded *without any surface damage* at pressures of 100,000 psi, while those using other lubricants were torn, galled or "frozen" to the point of breakage.



Photograph above shows mild steel test pins. No. 1: unused pin. No. 2 (lubricated .with mineral oil and Molysulfide) and No. 3 (with Molysulfide bonded coating) were subjected to rotating pressures between bearing halves. Both were elongated and extruded without galling, seizing, or weight loss. No. 4 shows typical failure with conventional lubricant. Note that the key sheared off and pin and block were galled and seized.

Extensive surveys among a great many independent laboratories indicate that the extrusion phenomenon produced with Molysulfide has never been achieved with any other conventional lubricant.

This proven load carrying ability of Molysulfide is only one of the reasons why grease compounders and lubrication engineers are investigating and testing new uses for MoS_2.

Other reasons include its extremely low coefficient of friction; its wide temperature range from –300 F to 750 F; its tenacious adherence to metal surfaces and a resultant great resistance to "scrape-off" and "wash-off"; and, its high chemical stability combined with long-life characteristics.

The uses for solid lubricants are multiplying. And—by test—Molysulfide is the superior solid lubricant.

When writing, refer to CL-111

nlgi spokesman

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THE COVER

THIS drawing describes in detail an apparatus designed and used by A. W. Sisko and L. C. Brunstrum of the American Oil company for measuring the permeability of lubricating greases. Pointing out that the permeability of pastes and gels should give useful information about the network of thickener particles in these colloids, the authors present equations for calculating permeability from the flow rate of the oil through the network. For more information on the "Permeability of Lubricating Greases," turn to page 72.

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NLGI PRESIDENT'S PAGE

By F. R. HART, *President*

Will You Be Ready to Market Lubricating Grease in the Year 2000?

The article that follows, second of four, confirms two facts previously discussed; ie, the continuing need for a highly specialized petroleum lubricating grease and a new market for exotic synthetic lubricants. These predictions are assuring in that the best scientific minds advise we will be in business 40 years from now, making and selling lubricating grease. However, the catch is, petroleum greases of tomorrow will be much better lubricants in that they will protect bearings for *abnormally* longer service periods. So, do not be lulled into the false security of "business as usual." If you do, you may find you have not kept pace with technical improvements.

Our forecaster this month is Mr. Harold Frazer, vice-president of International Lubricant Corporation, New Orleans. Mr. Frazer developed Lithium 12 Hydroxystearate grease—a lubricant that startled the industry and changed the entire concept of petroleum grease lubrication. He is eminently qualified to tell us about the future need for lubricating grease.

Actually, the kind of greases needed 40 years from now will depend on many factors, over which the grease chemist has no control. For instance—the types of bearing used, materials from which bearings are made, as well as the design, speed and operating temperatures of new machines all play an important part in future lubrication. A glance at the crystal ball, however, shows a few basic facts that may provide a hint as to what may happen. It appears industrial equipment will fall into two broad categories:

1. "Run of mine" or normal machines, and
2. New, high speed, high operating temperature machines; new nuclear machines—as well as space rockets, etc.

In the first category, the machines will be economically designed to keep their original cost low and for easy maintenance. Each machine will be equipped with labor-saving automatic lubricators. Vastly improved greases will help these machines operate over longer periods of time, thus lowering production costs.

With regard to new products, the organic chemist will never synthesize a substitute as cheaply as Mother Nature did over many years, so petroleum lubricants will still be in big demand for many years to come. The better products to be developed will be fortified through the use of inhibitors and additives to provide improved lubricity and stability. The demand will be large as the industrial machines of tomorrow will work harder and longer to produce the things needed by man in the year 2,000.

The second category defines the need for new synthetic lubricants. The pattern of developments in grease research will unfold as new machines are brought into use. Chemists now have a fair idea as to speeds and temperatures that will be encountered, and they are working on exotic lubricants to satisfy these requirements. There is no question that entirely new lubricants will be needed. Exceedingly high temperatures, high speeds must be pacified—undoubtedly by synthetic lubricants—or other products conceived by the research chemist.

The foregoing opinion is further evidence that lubricating grease research is more important now than at any previous time. This observation tells us that better products will be needed to lubricate rapidly changing industrial machinery.

Next month we will report the views of an Easterner on this interesting subject. We think you will like them because of the distinction placed on the lubrication needs of earth-bound equipment as opposed to air-borne equipment. Here we learn something about the automobile of the future, as well as newer modes of transportation. ■

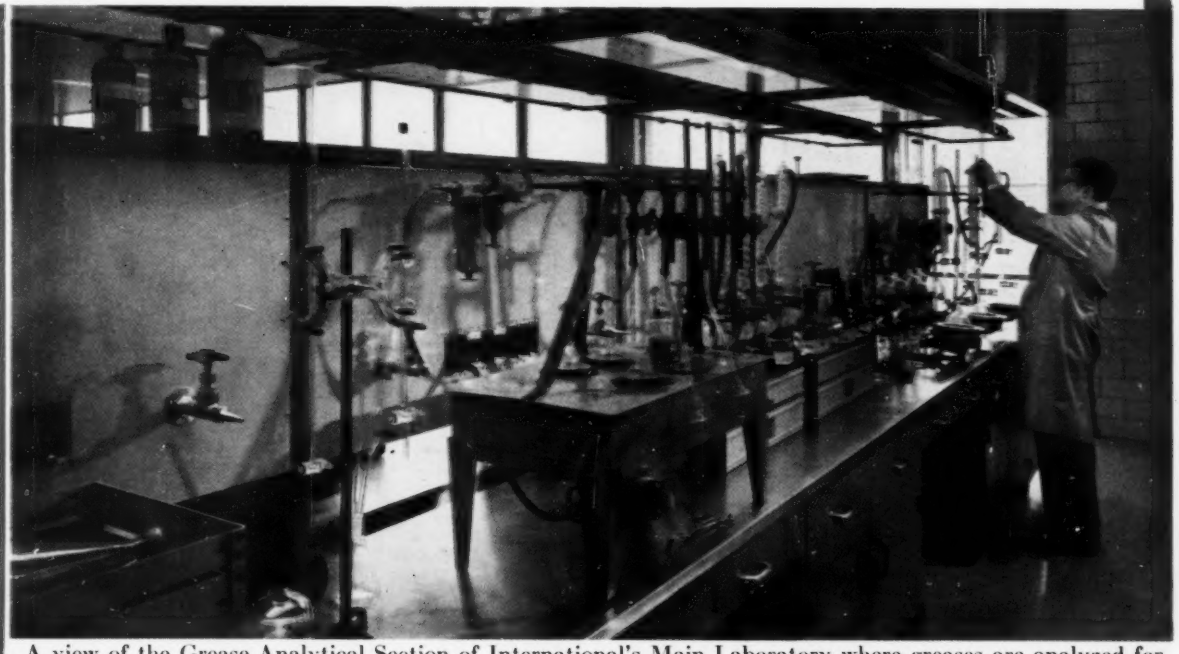
GREASE MARKETERS CAN PROFIT FROM INTERNATIONAL'S NEW RESEARCH LABORATORY

Testing a wheel bearing assembly to see how well the grease has maintained its original quality under simulated operating conditions. For 30 years International has pioneered in this "actual usage" type of experiments.

Quality and dependable performance are prime requisites of grease marketers who value the integrity of their brand names.

"*With Research Comes Quality—With Quality Comes Leadership*" is more than a slogan with the folks at International.

The recently expanded research laboratory, containing the most complete and advanced testing equipment to be found in the field of grease manufacture, is another example of how International is intensifying its efforts to further improve products which will keep present customers happy and attract new ones.



A view of the Grease Analytical Section of International's Main Laboratory where greases are analyzed for percentage and type of soap and oil.

INTERNATIONAL LUBRICANT CORP.

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Manufacturers of top quality lubricants: Aviation • Industrial • Automotive • Marine

With Research Comes Quality, With Quality Comes Leadership

Future Meetings

JUNE, 1961

11-15 ASME Summer Annual Meeting, Statler Hilton Hotel, Los Angeles.

15-16 Petroleum Packaging Committee, Packaging Institute, Chicago, Ill.

24-29 ASTM Committee D-2 meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

SEPTEMBER, 1961

11 NLGI Board of Directors meeting, Roosevelt Hotel, New York City.

13 API Division of Marketing, Lubrication Committee Meeting, Traymore Hotel, Atlantic City, N. J.

13-15 National Petroleum Association, Annual Meeting, Traymore Hotel, Atlantic City.

24-26 Independent Oil Compounders Association, Annual Meeting, Villa Moderne Motor Hotel, Highland Park, Ill.

24-28 ASTM Committee D-2 meeting, Statler Hotel, Detroit.

OCTOBER, 1961

17-19 ASME-ASLE Lubrication Conference, Hotel Morrison, Chicago.

OCT. 29 - NOV. 1, 1961 NLGI Annual Meeting, Rice Hotel, Houston, Tex.

NOVEMBER, 1961

9-10 SAE National Fuels and Lubricants Meeting, headquarters undecided, Houston, Tex.

13-15 American Petroleum Institute Annual Meeting, Conrad Hilton Hotel, Chicago.

26-Dec. 1 ASME Winter Annual Meeting, Statler Hilton Hotel, New York.

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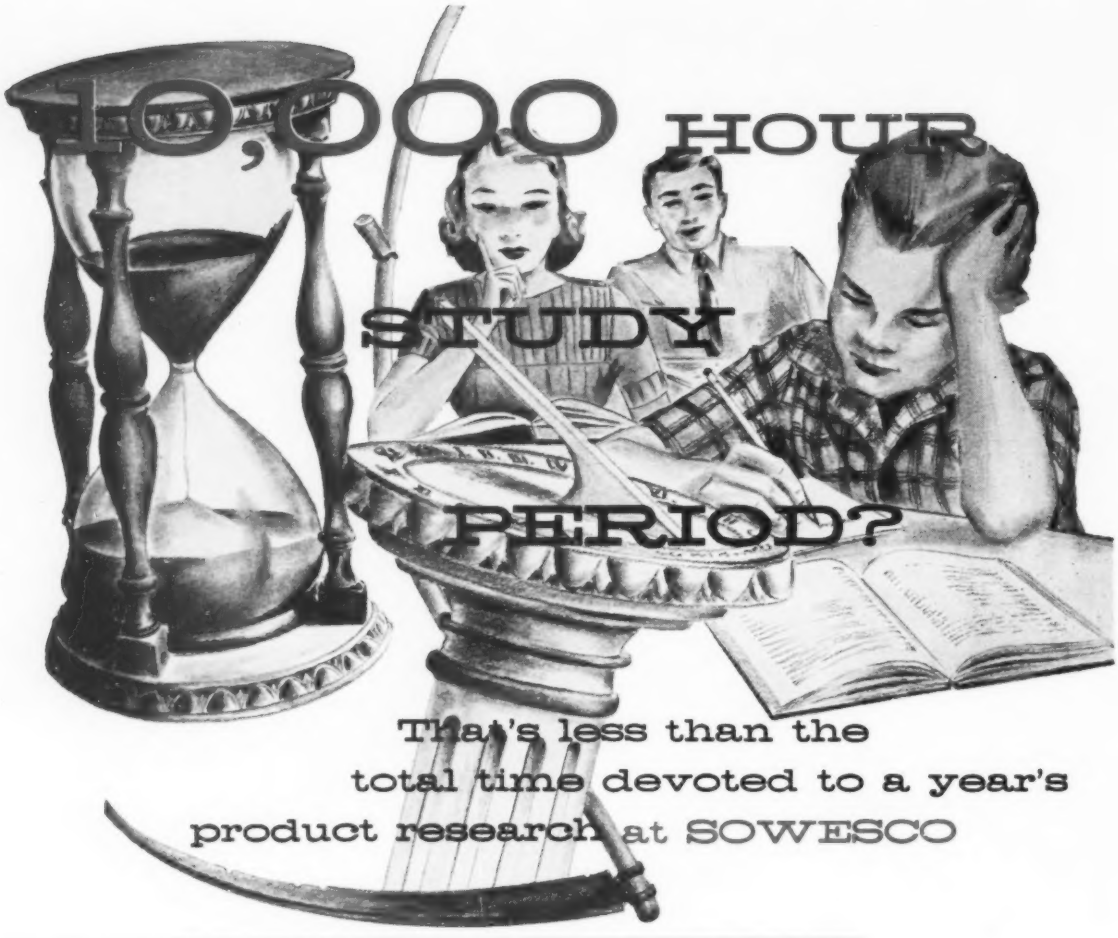
NEW HOME FOR AN OLD CATO HAND; SAME CONTROLLED-QUALITY GREASE

Our head greasemaker, after 14 years of experience, is now at home in our new grease manufacturing plant — a facility which contains the finest equipment obtainable for the manufacture of quality grease.

Manuel Davis knows from experience when a kettle of grease is ready for packaging. His opinions are laboratory tested at every stage along the way, of course, but it's amazing how often these scientific tests confirm the accuracy of Manuel's practiced eye and touch.

The point is, we're delighted with our new facilities, but realize they're worth little without men like Manuel Davis who know how to use them. We'd appreciate an opportunity to prove that Cato know-how and equipment is a team that can't be beat.

CATO OIL AND GREASE COMPANY
Oklahoma City, Oklahoma



Ten thousand hours is a long study period... but it's a study period repeated year after year at **SOWESCO**... resulting in a sustained productive laboratory research program that makes available to our customers the most complete selection of customized, modernized lubricants ever available to branded marketers.

This 10,000-hour study period involves a never-ending search for saleable products... products tailored to solve your problems, be they problems of performance, packaging, or price.

Yes, a 10,000-hour productive, successful annual research program is another reason why we at **SOWESCO, the HOUSE of "good" GREASE** recommend that progressive branded marketers should Look Behind the Product for **"THE HIDDEN VALUE FACTORS."**

Your inquires will be enthusiastically received and handled.

New Grease Plant Layout

By:
M. E. Erwin
and
J. C. Gebhart
Gulf Oil Corporation

FIGURE 1.

Presented at the NLGI 28th annual meeting in Chicago, October, 1960

ENGINEERS and others interested in the design of new grease plants will find relatively few sources for layouts of complete new grease plants that have been designed for present day manufacturing procedures. This situation is largely the result of the long life of grease making equipment which promotes the expansion of an old plant rather than complete redesign and rebuilding. It is hoped that this paper will be helpful in improving this situation to some extent. An attempt to accomplish this objective will be made by describing a modern grease plant, now in operation, which was designed and built as a complete unit in close proximity to, and as an integral part of related operations. Following the old adage that "seeing is believing", this paper consists mostly of brief descriptions of various views of the grease plant's arrangement and its equipment.

A visitor at Gulf's new grease plant in Port Arthur, Tex., will readily be aware of a "new look" . . . a "new look" in the sense of being different as well as new in construction. If the visitor is an engineer, he will recognize a "new look" in the size and arrangement of the plant and arrangement of up-to-date equipment. A layman will be aware of a "new look" in the unexpected display of color along with design which presents an appearance of cleanliness and lends itself to easy housekeeping. These are conditions which generally are not associated with actual grease manufacturing operations by most laymen.

The new grease plant, which was completed in 1959, is a part of a fifteen-acre installation designed for the

filling and shipping of tank cars, tank trucks, drums, and packages of blended and compounded oils, greases and specialties. The buildings of the installation cover approximately eleven acres (over 500,000 sq. ft.), the remainder of the area being used for tank farms, truck loading, pallet storage and other accessory functions. The installation includes facilities for receiving and storing empty containers, raw materials and oil stocks; equipment for compounding, oil blending and grease-making; filling equipment for containers ranging from four-ounce cans to drums, tank cars and tank trucks; warehousing facilities for storing and shipping; offices, a maintenance shop, and a laboratory for servicing the various operations.

These facilities were designed with emphasis on maximum production with minimum manpower. Adequate modern equipment was provided to accomplish this goal. Each section of the installation was designed to operate as a unit and an integral part of the whole installation, the grease plant being one of the integral sections.

Figure 1 is an over-all aerial view of the complete installation. The section of the building on the south side (right side in view) is a seven-acre warehouse for filled containers. Orders are filled from this warehouse which has outside truck and van loading in front (the east side) and box car, barge and lighter loadings within the south side of the building. There is a five-track box car loading dock that will handle 35 box cars simultaneously in the front part of the building and a 60 ft. x 400 ft. barge slip in the rear section that will accommodate two large barges. A barge is seen at the entrance to the slip in this view. Both box car and barge loading facilities are under the roof for all-weather operation.

The two tank farms shown in the view include a total of 127 tanks, ranging from 200 to 2,000-barrel capacity, which furnish storage for base oils, additives and finished products. Most of the tanks on the east side or in front of the buildings are for finished oils and products to supply packaging operations. The west tank farm primarily supplies the grease and compounding plants with base oils and additives although some finished products are also stored in this group. Both tank farms have been included in the over-all color scheme to improve the appearance of the plant.

Remote-controlled, electric-powered, positive displacement pumps with capacities of approximately 150 gpm are used to move the stocks into the building when required. Each pump is equipped with a pressure bypass which returns the material to the tank when flow through the line is decreased or stopped for any reason. In general, each tank has its own three or four-inch line leading into various operations in the building. A few of the tanks have return lines for circulation and some have steam traced lines. Many of the tanks are equipped with heating coils with automatic temperature and pressure controls.

Adjacent and opening into the warehouse on the north side is a one to three-story building housing (from front to rear on the first floor) offices, specialty-line filling, motor-oil can filling, drum filling and grease filling. All filling operations move from the north side, where box cars enter and leave container unloading platforms through the filling lines to the warehouse. Storage areas for empty containers are lo-

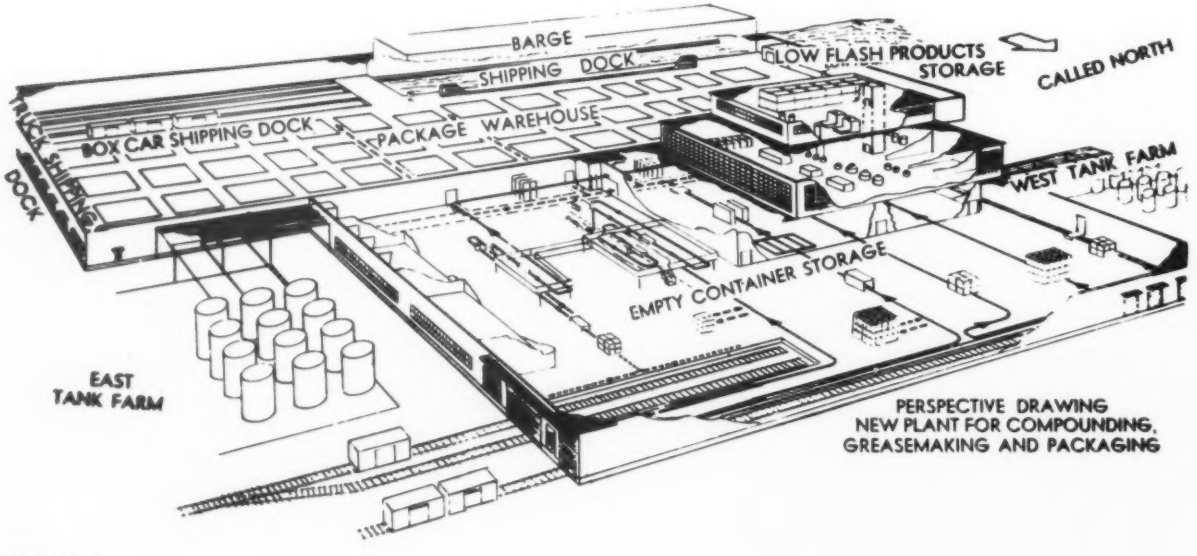
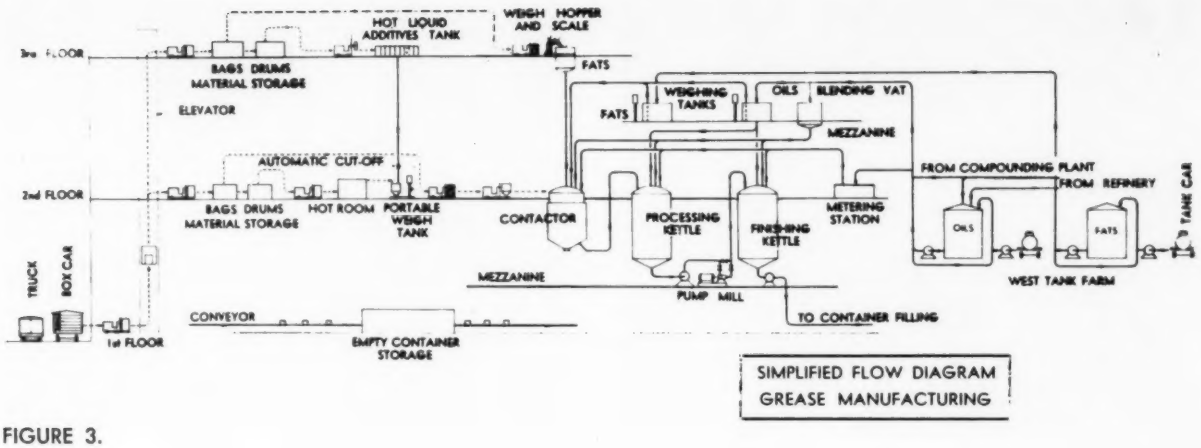


FIGURE 2.



SIMPLIFIED FLOW DIAGRAM
GREASE MANUFACTURING

FIGURE 3.

cated in areas north of each of the filling lines. Figure 2 shows a general flow of these operations.

The grease plant is located in the rear of the three-story building parallel and adjacent to the compounding plant. The three floors serve both of these plants with filling operations on the first floor, manufacturing operations on the second floor, and raw material storage on the third; the grease plant also has related operations on two mezzanine floors.

The grease plant operations flow follows the five-level arrangement illustrated by Figure 3. Raw materials move from the fifth level (third floor) to lower levels for processing. On the fourth level (second floor mezzanine) there are various types of weigh tanks, meters and oil vats for measuring and handling oils and other materials. The third level (second floor) is the main operating level where practically all of the manufacturing operations are accomplished. The function of the second level (first floor mezzanine) is to furnish easy access to grease pumps, screens, transfer lines, homogenizer and mills. The first level (first floor) is the filling area.

Figure 4 shows a view of raw material storage in palletized drums, bags, and cartons on the fifth level. This storage area is approximately 20,000 sq. ft. and equipped with a 10-ton hydraulic elevator which serves each of the three floors of the building.

Figure 5 is a view of two 3,000-lb. weigh hoppers on the fifth level where solid fats and fatty acids are weighed for transferring into contactors on the third level.

Figure 6 shows some of the 300-barrel additive tanks on the fifth level which are used for liquid additives. These tanks are equipped with automatic temperature control and individual pumps and lines.

As mentioned before, raw materials on the fifth level move to lower levels, one of which is the fourth level as shown in Figure 7. Here we see rows of oil vats, weigh tanks, meters and the two weigh hoppers protruding through the fifth level. In general, components of soap batches are measured by weight and larger

FIGURE 4.

FIGURE 5.

FIGURE 6.

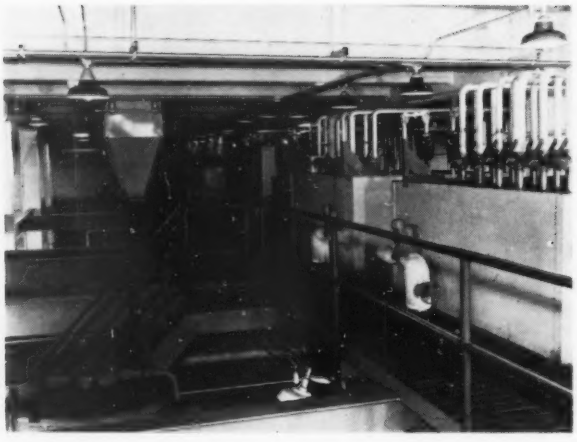


FIGURE 7.

volume hydrocarbon components are measured by temperature compensating meters.

There are eleven vats for oil and liquid fats on the fourth level ranging in size from 600 to 2,700 gallons. Some are weigh tanks for liquid fats or mineral oils, while others are equipped with meters and automatic gauges for measuring oils. Most of the tanks have heating coils with automatic temperature regulation.

Oil and liquid fats are pumped to the vats from tank farms with pumps that are operated from the control board shown in Figure 8. Signal lights on the board indicate which pumps are operating. Also shown in Figure 8 are temperature and pressure recorders for grease kettles which are on the operating floor of the grease plant. This is the second floor of the building and the third level illustrated in Figure 3.

There are two parallel rows of grease vessels with a total of fourteen grease kettles and three contactors on this floor. The kettles range in size from 3,000 to 35,000 lbs., some with double and others with single motion agitation. The contactors have capacities of 6,000 lbs.

In general, grease batches are started with pressure saponification and dehydration in one of the contactors and then transferred to one of the 25,000-lb. kettles for preliminary finishing. The batches are next milled to one of the 35,000-lb. kettles where final finishing is accomplished. The grease kettles were designed and are used mainly for solid and semi-solid grease, while automotive axle and gear lubricants and other large volume semi-fluid products are made in the compounding plant in much larger equipment than the grease kettles.

Figure 9 is a view of the rear of one of the rows of grease kettles. This view was made with the camera placed approximately in front of the control board shown in Figure 8. The three contactors are in the left center of the picture. Directly above them are the weigh hoppers that are used to weigh dry fats and fatty acids into the contactors. Dry alkalies are weighed into the contactors on the operating floor with the use of a portable hopper and scale arrangement which affords almost complete mechanical handling with minimum exposure of personnel. The oil

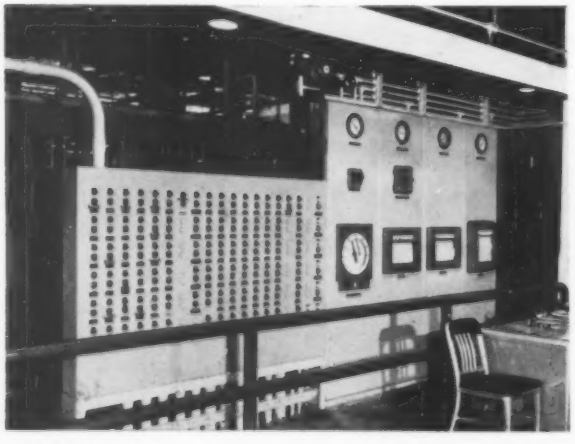


FIGURE 8.

FIGURE 9.

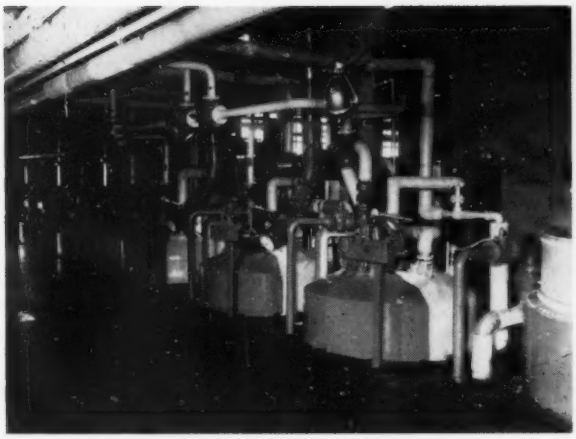


FIGURE 10.

FIGURE 11.

vats shown in Figure 7 can be seen in the upper background. One of the drives on a 35,000-lb. kettle can be seen on the right. The two 12-inch pipes rising vertically in the foreground and extending horizontally to above the contactors are part of the kettle exhaust system. This system will be described later in more detail.

The three 6,000-lb. contactors may be seen in more detail in Figure 10. The flexible transfer chutes leading from the weigh hoppers are also clearly shown. The three contactors are driven with 75 hp., two-speed motors which are shown in Figure 11. This view was taken on the second level of the grease plant immediately below the operating floor. Heating of the contactor vessels is accomplished by the use of a hot-oil heating medium with no cooling used or required in this step of the manufacturing process.

Figure 12 provides another view of the contactors and some adjacent kettles. The large kettle in the foreground is a 35,000-lb. kettle with double-motion stirring. The outer sweep with leading hinged scrappers is driven at 13.8 rpm by a 75 hp. motor, while the inner paddles are driven by a two-speed 125/62.5 hp. electric motor at 30 or 15 rpm. The kettle is designed for operation from 125 pound per square inch pressure to 26-28 inches mercury vacuum and has separated upper and lower jacket sections for heating with either saturated or superheated steam and for cooling with water. Cooling water is furnished by an inclosed inhibited system which utilizes a cooling tower with 5,000,000 BTU-per-hour capacity at the designed conditions. The manhole cover is hydraulically operated. The large pipe over the manhole is part of the exhaust system.

Figure 13 shows the drives on the kettle from the back side. Also shown in the view are the two kettle exhaust system blowers and some of the duct work. The exhaust duct from the blowers extends directly through the roof to the outside. The suction duct work leading to the blowers extends through the floor level below the kettle man-heads where a main header picks up a suction vent near the man-head of each kettle. The vent near each kettle man-head is purposely looped up to the man-head from the main duct below

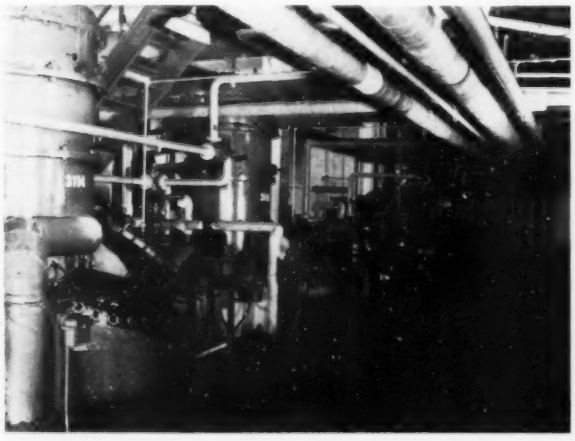


FIGURE 12.

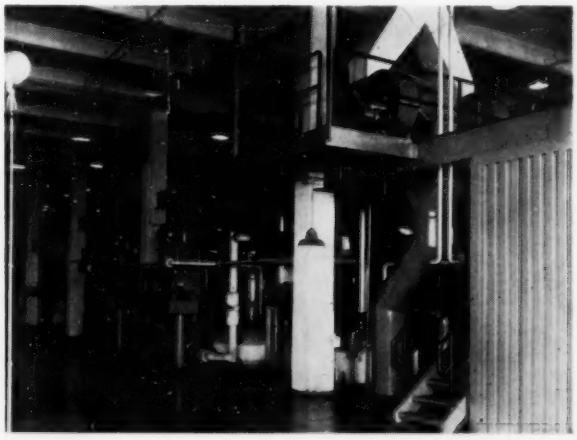


FIGURE 13.

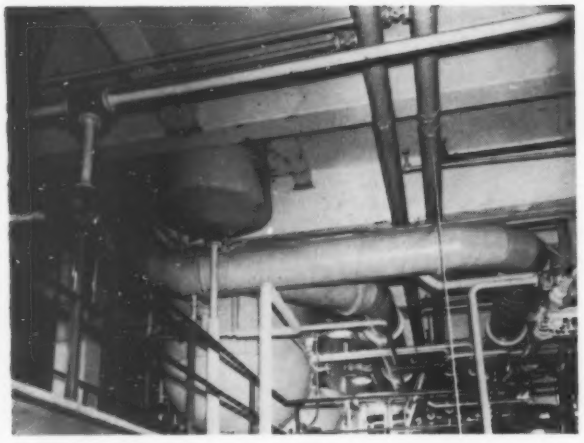


FIGURE 14.

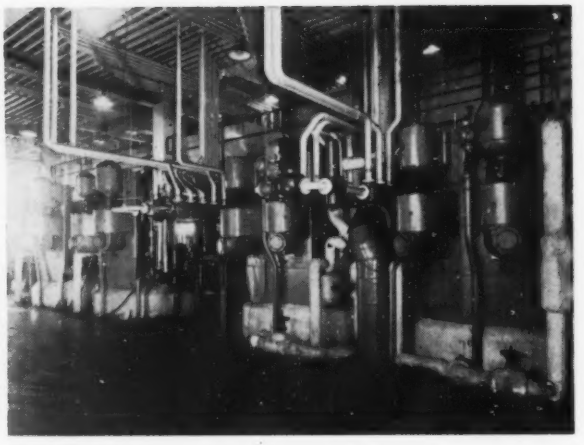


FIGURE 15.

to provide maximum removal of condensing vapors from the kettle man-head. This prevents condensate from draining back into the kettle. The lowest point in this vapor collecting system is provided with a trap for removal of liquids which are collected.

Figure 14 shows how the duct work runs under the floor and branches off to each vessel.

The rear of the other row of kettles appears in Figure 15. Note that the drives on some of these kettles are vertical, providing a valuable saving in aisle space. The kettles with the vertical drives are 15,000 and 25,000 lb. capacity and have a paddle arrangement and other features similar to the 35,000-lb. kettle described previously.

Figure 16 and Figure 17 show views of a vertical superheater and one of the hot-oil heaters with its control board. Two hot-oil heaters are in the heater room which is located on the operating floor (third level) adjacent to the grease kettles for easy access to operating personnel. The capacities of the two gas-fired hot-oil heaters are approximately 3,000,000 BTU/hr. each. The superheater and hot-oil heaters are automatically controlled. The heater room is protected with an automatic water-fog fire protection system.

A laboratory including grease development and routine testing sections is also located on the third level in close proximity to the operating area of the grease kettles. Figure 18 is a view inside of the testing section. As in the grease plant, ease of housekeeping was an important part in the design of the laboratory. The furniture is standard laboratory steel furniture with stainless steel tops and was selected for its functional and easy to clean features. The walls in the laboratory are glazed tile and the floors smooth hardened-concrete as in the grease plant. Equipment of particular interest in the testing section includes the water-cooled stainless steel tubes in the left center of the picture and the Timken tester in the left corner of the room. The water-cooled tubes are used to cool hot grease samples for quick penetration tests in order that consistency adjustments can be made on grease batches with minimum loss of time. The Timken tester is equipped with a new design of a grease-feeding device and an auto-

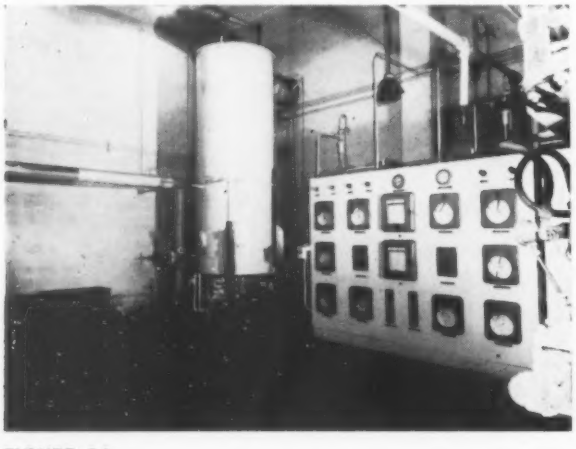


FIGURE 16.

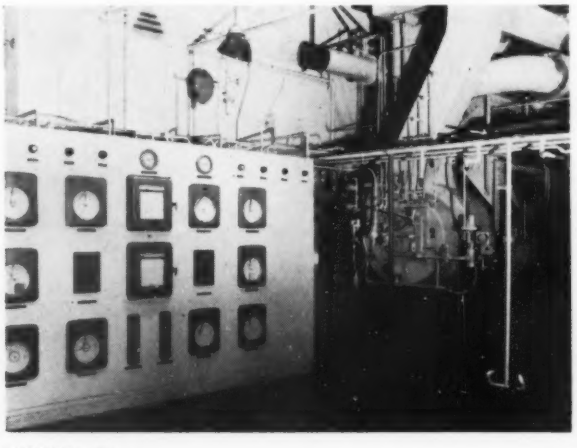


FIGURE 17.

FIGURE 18.

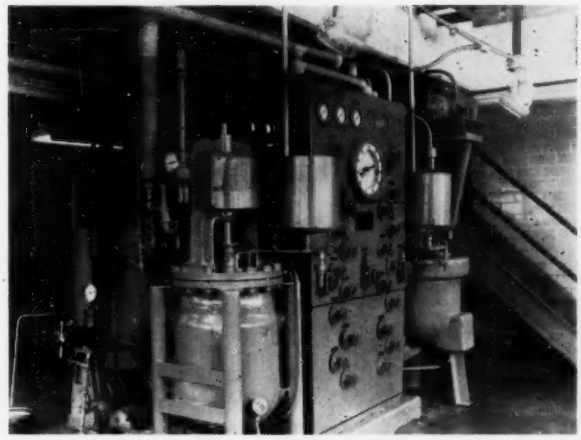


FIGURE 19.

matic weight loader, both of which contribute to accuracy.

Figure 19 is a view of two 100-lb. experimental grease kettles and their control board in the grease development section. A 100-lb. contactor is located in the mezzanine above the kettles and is also controlled from the control board.

The laboratory was located as close as practical to the grease plant's operating area to provide prompt sampling and testing service. With this prompt service, it is practicable to leave the grease in the kettle until the quality is determined, which minimizes the amount of processing that is required.

The second level which is immediately below the operating floor is a concrete mezzanine designed for access to the bottom of the grease vessels, the pumps and screens, the homogenizer and grease mills. Figure 20 is a general view of the area and shows a homogenizer and mill. It can be seen that the floor provides ample room and ready access to the screens, pumps and other accessories. The floor is connected to the upper operating area and lower filling area by short stairways.

Figure 21 is a view of a typical pump and screen arrangement that is used on various kettles. The pump is the rotary positive displacement type and has a capacity of approximately 75 gallons/minute at working pressure of 100 pounds per square inch. There are two parallel basket-type screens in the screen assembly so that one can be cleaned while the other is in use. The pump is equipped with a pressure-regulated bypass valve which will return grease to the kettle should the screens become plugged. All filling and a considerable amount of finishing of greases are done through the screens.

Grease filling is accomplished by manual and semi-automatic equipment on the first level (first floor) of the grease plant. Empty containers are fed from box cars or storage to the various filling lines.

Figure 22 is a view of empty drums moving on powered conveyors to the filling lines. There are four railroad tracks which provide space for twenty box

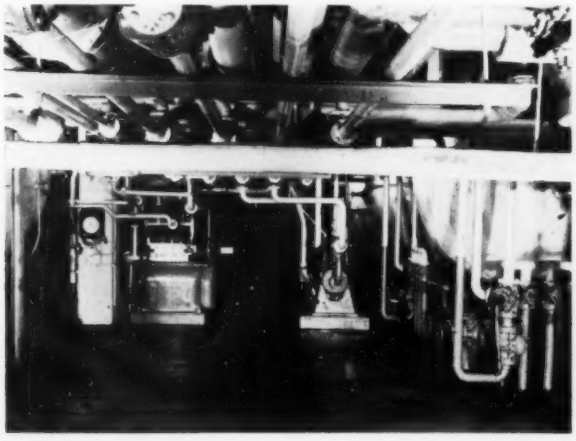


FIGURE 20.

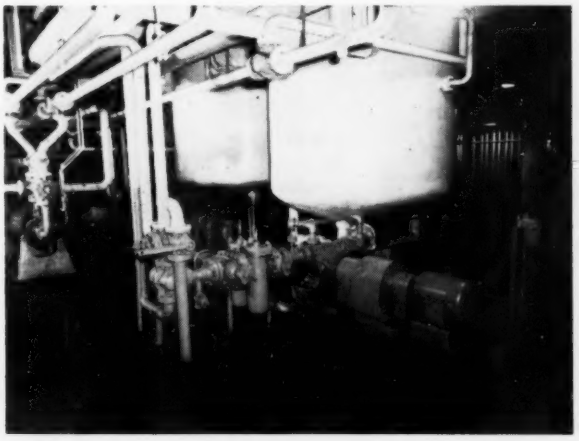


FIGURE 21.

FIGURE 22.

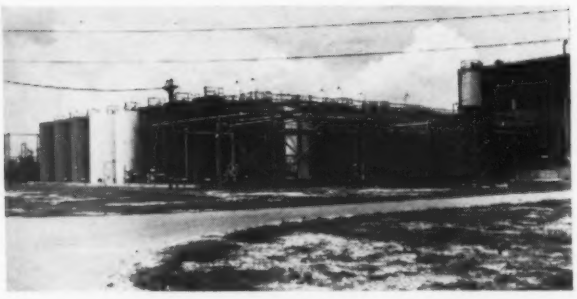


FIGURE 23.

cars in the unloading area of the building. Wide doors in the north wall of the building provide access to trucks and box cars which may be parked or spotted outside of the building. Two railroad tracks run along this wall and lead to tank car unloading facilities at the west tank farm in the rear of the building. Figure 23 is a view of this tank farm. The water cooling tower described previously as part of the cooling water system for grease kettles is on the right.

Empty containers move from the storage and/or

FIGURE 24.

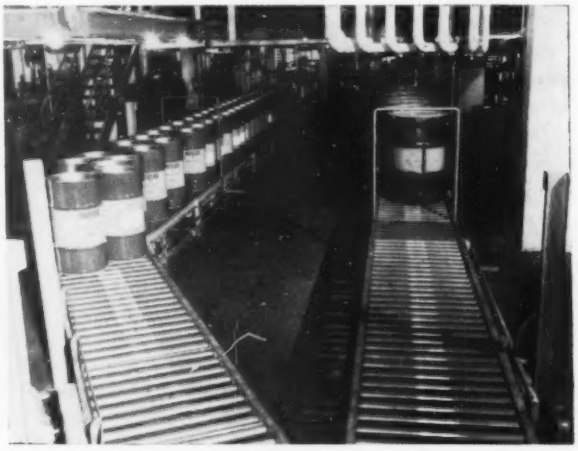


FIGURE 25.

M. E. Erwin *graduated from Texas A & M college with a degree in chemical engineering in* 1934. *The same year, he joined Gulf Oil Corp. in the experimental lab at the Port Arthur, Tex., refinery. He served as foreman in charge of grease plant operations until* 1957, *when he became superintendent of the package and grease department. From* 1941 *to* 1946, *he was a chemical officer in the Air Force, serving as lieutenant colonel when released from active duty. He is a member of Tau Beta Pi.*

About the Authors

J. C. Gebhart *graduated from Texas A&M college with a degree in chemical engineering in* 1933. *He joined Gulf Oil Corp. at Philadelphia, Pa., the same year. He served as foreman of the semi-works grease plant, refinery technology laboratory, Philadelphia, from* 1935 *to* 1943. *A member of the American Chemical Society, Mr. Gebhart is now foreman of the package and grease laboratory at Port Arthur, Tex.*

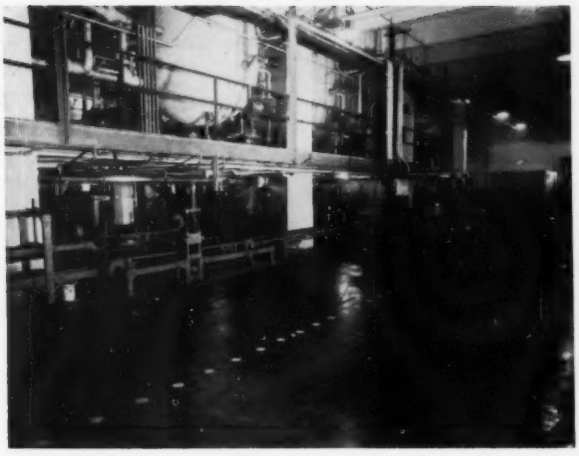


FIGURE 26.

unloading area through two openings in the wall between the grease plant and the container storage area. Figure 24 shows drums moving to one of these openings to the filling area. Note that these openings are equipped with fuseable link trap doors for fire protection. Figure 25 is a view of drums which have moved through one of the openings and into position for filling. One of the semi-automatic filling stations is located at the far end of the 120-lb. drums. This station is equipped with a scale that automatically stops the grease stream when a drum is filled to the proper weight. Just past the filler is an automatic crimping machine. After the lids are crimped on, the drums move by conveyor to a palletizing area and are then taken to the warehouse for storage by fork lift trucks.

There are two main filling lines which have combination powered and gravity conveyors in the grease filling area. Each line is equipped with branch conveyors which lead to special devices for filling five-lb. cans or 35-lb. pails.

Filling of 8-oz. plastic tubes is done on the machine shown in Figure 26 which also shows some of the filling area.

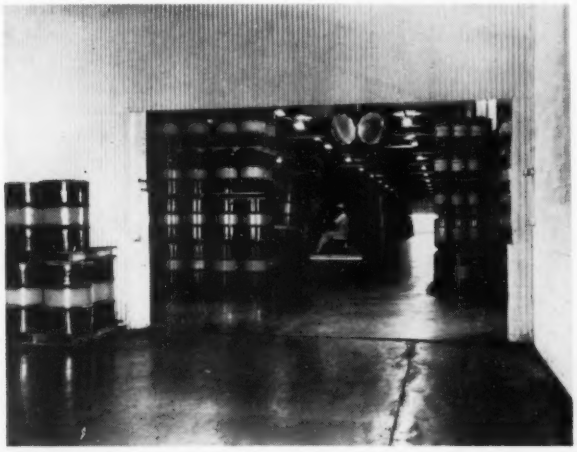


FIGURE 27.

All containers are palletized and moved into the warehouse by fork lift trucks as illustrated in Figure 27, or they may be carried directly to barges, trucks or box cars for shipment.

Figure 28 is a view of an overhead crane loading a barge in the slip which is inside the warehouse building. The loaded barges are moved by tugs either as lighters for loading dry cargo vessels or as barge shipments on the intercoastal canal or inland waterways. From the barge slip in the warehouse, it is only a short distance to the intercoastal canal which can be reached through the ship channel.

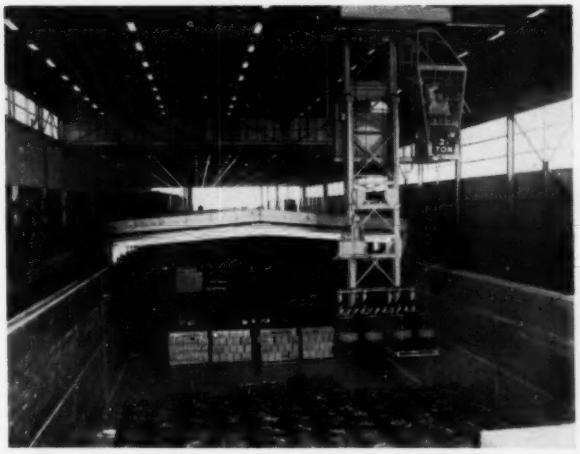


FIGURE 28.

The grease plant which has been described represents one approach to the problem of manufacturing a wide variety of greases with the least expense. The layout was designed to fit specific needs and is not presented as the best or as meeting universally the needs of all grease plant layouts. However, some of the features are basic to low cost grease production and worthy of re-emphasis. These features include, (1) the efficient flow of materials and containers afforded by the five-level arrangement, (2) maximum practical mechanization and automation of the equipment, (3) appropriate size of equipment, (4) arrangement of equipment for ease of operation and accessibility, (5) minimum length and adequate number of pipe lines and (6) the good environment for operators provided by the general neatness of the plant, the ventilation systems, color scheme, etc.

Operational experience with the grease plant has been very satisfactory. Although some minor changes in piping, etc. have been necessary, no major changes have been needed in the equipment or its arrangement. Indications are that the expense of providing appropriate equipment to keep labor costs at a minimum will prove profitable. ■

Permeability of

By: A. W. Sisko and L. C. Brunstrum
American Oil Company

THE DISPERSE phase of a lubricating grease is a network of particles with oil trapped in the interstices by capillary forces. The size and shape of individual particles can be determined by electron microscopy, and the work required to steadily deform the network can be measured by rheological methods.[5] Experiments with the isolated network separated from the oil by the use of the aerogel technique[2, 4] show it to be a porous, fragile structure.

Permeability to liquids or gases is a property often measured in studying porous materials. Because permeability is determined by such factors as the size, shape, concentration and dispersion of particles in the network, it holds promise of extending our knowledge of grease structure. The permeability of greases and of other colloids that exist as pastes or gels can be determined by measuring the flow rate of the continuous phase through the disperse phase under carefully controlled conditions.

Permeability calculations are based on Darcy's Law:[3]

$$u = \frac{BP}{\eta L} \qquad (1)$$

where u is the velocity, in cm. per sec., of the fluid flowing through the sample; P is the pressure drop, in dynes per cm.^{2}, across a sample of thickness L cm.; and η is the viscosity of the fluid, in poises. Permeability, B, has the dimensions of cm.^{2} but is better described as the cc. per sec. of fluid flowing through a unit cube of the porous material under a pressure drop of 1 dyne per cm.^{2}.

An apparatus for measuring the permeability of lubricating greases has been designed and used to make

FIGURE 1—Permeability apparatus.

Lubricating Greases

Presented at the NLGI 28th annual meeting in Chicago, October, 1960

two series of measurements. In one, the permeabilities and ASTM oil separations[1] of four greases were measured. In the other, permeability was related to the dispersion of thickener fibers in five greases. These exploratory studies suggest promising lines for future research.

Experimental

An apparatus for measuring permeability must pro-

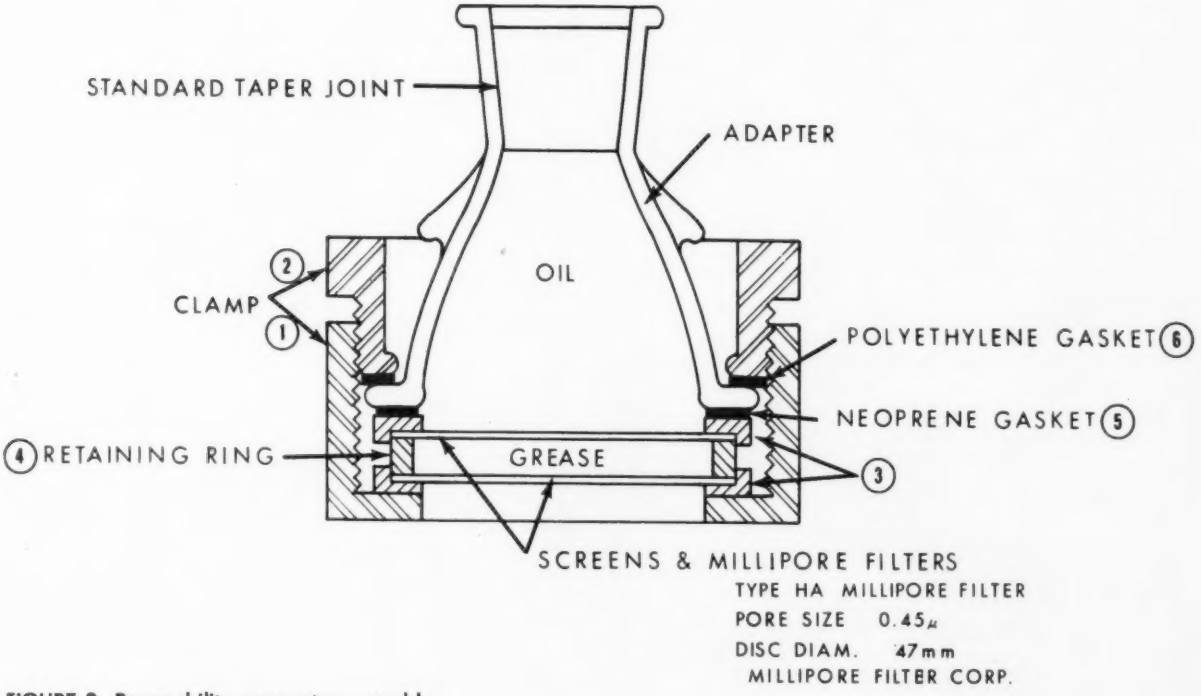


FIGURE 2—Permeability apparatus assembly.

vide a means for measuring flow rates, under known pressure drops, through a sample of fixed thickness and area. The apparatus devised for use in this work is pictured in Figure 1. It consists of a 5-ml. burette 20 cm. long connected by a glass adapter to a sample assembly. All machined parts are of stainless steel.

A cross-section view through the adapter and sample assembly is shown in Figure 2. The sample, in the form of a disk 0.5 cm. in thickness and 4.16 cm. in diameter, is retained by a steel ring between millipore filters (Type HA). The filters are supported by 40-mesh screens soldered into other rings. Sample assembly and adapter are held together by a screw clamp.

Figure 2A is a detailed drawing of the permeability apparatus.

In assembling the apparatus, the filters are placed on the screens and wetted with oil. Excess oil is gently removed with absorbent tissue. The retaining ring is placed on the bottom filter, and grease is packed into the ring and leveled. Care is taken to avoid entrapping air. The top filter is then added, and the sample assembly placed in the bottom half of the clamp. In succession, a butyl rubber gasket, the glassware, a polyethylene gasket and the top half of the clamp are added. The clamp is screwed together as tightly as possible by hand. The burette is attached and filled with oil filtered from a separate portion of the grease.

Permeabilities are determined by allowing the oil to flow through the grease under its own head. The change in oil height above the sample is measured as a function of time. If R_1 is the radius of the sample, R_2 the radius of the burette, and h the height at time t, the velocity of flow is:

$$u = -\frac{R_2^2}{R_1^2}\frac{dh}{dt} \qquad (2)$$

The pressure drop across the sample is ρgh, where ρ is the density of the oil and g is the gravitational constant. Substituting these values of u and ρ into the equation for Darcy's law gives the permeability equation:

$$-\frac{R_2^2}{R_1^2}\frac{dh}{dt} = \frac{B\rho gh}{\eta L} \qquad (3)$$

Because η/ρ is the kinematic viscosity μ, this equation can be written:

$$B = -\frac{2.303\ \mu L\ R_2^2}{g\ R_1^2}\frac{d\ \log\ h}{dt} \qquad (4)$$

Collecting the constants gives:

$$B = -k\frac{d\ \log\ h}{dt} \qquad (5)$$

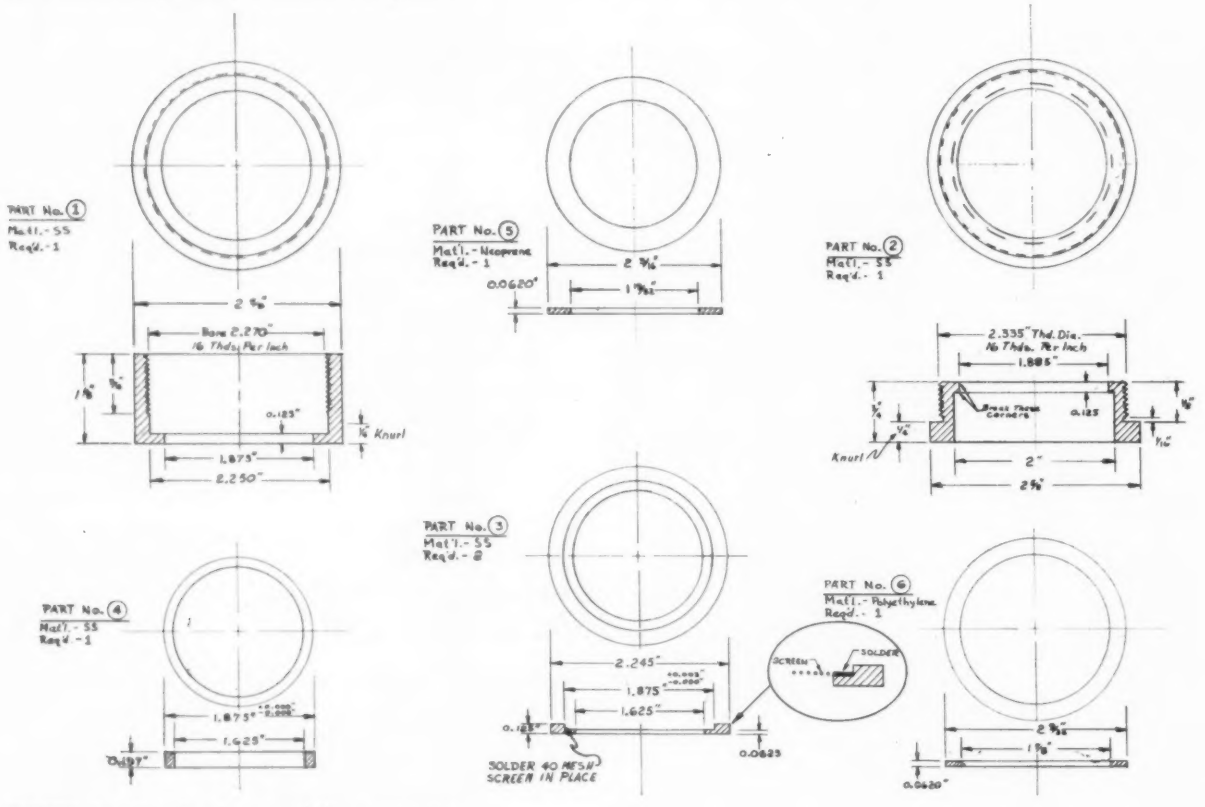


FIGURE 2A—Details of permeability apparatus.

The permeability can be calculated by substituting into Equation 5 the slope of a plot of log height against time.

If many tests are to be run routinely, it may be more convenient to measure the time required for the oil height to drop from one fixed level to another. Substituting $u = \frac{Q}{\pi R_1^2}$ and $P = \rho g \bar{h}$ into Equation 1 and rearranging gives:

$$B = \frac{\eta\ L\ Q}{\pi\ R_1^2\ \rho g \bar{h}} = \frac{\mu\ L\ Q}{\pi\ R_1^2\ g \bar{h}} \qquad (6)$$

where Q is the volumetric flow rate and $\bar{h}$ is the logarithmic mean height of oil:

$$\bar{h} = \frac{h_2 - h_1}{2.303\ \log \frac{h_2}{h_1}} \qquad (7)$$

in which h_2 and h_1 are the oil heights at the start and end of the experiment.

The 40-mesh screens and millipore filters impose a resistance to flow that must be considered in calculating the permeability of the grease. The needed correction is measured by setting up the apparatus with oil substituted for the grease. The reciprocal of the permeability is the resistance to flow and these resistances are additive:

$$\frac{1}{B_t} = \frac{1}{B} + \frac{1}{B_o} \qquad (8)$$

Where B_t is the permeability of the grease plus screens and filters, and B_o is the permeability of the screens and filters alone. The permeability of the grease is then:

$$B = \frac{B_t\ B_o}{B_o - B_t} \qquad (9)$$

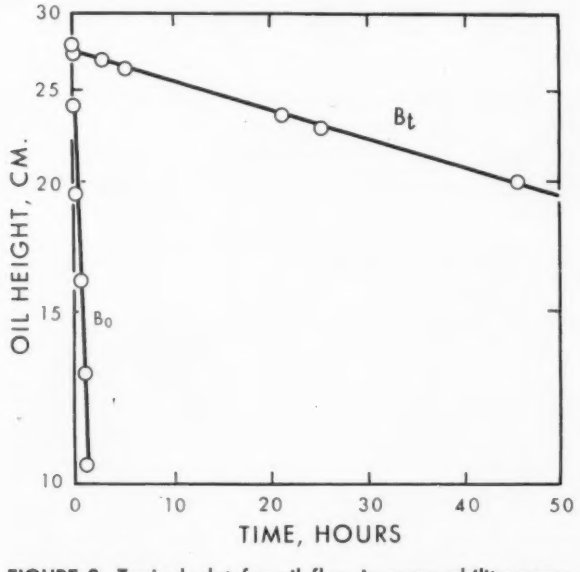


FIGURE 3—Typical plot for oil flow in permeability apparatus.

Plots of log oil height against time, as predicted by Equation 5, are linear. A typical plot for a lithium grease plus screens and filters and for the screens and filters alone is shown in Figure 3. These have slopes of -7.95×10^{-7} sec.$^{-1}$ and -7.59×10^{-5} sec.$^{-1}$, respectively. By either Equation 5 or 6, B_t and B_o are 2.99×10^{-11} and 2.85×10^{-9} cm.^{2}. The permeability of the grease, from Equation 9, is 3.02×10^{-11} cm.^{2}. Although the correction is small in this case, it becomes very significant for highly permeable greases.

Application of Permeability to Grease Structure

Permeability was applied to two problems related to the structure of the thickener network: oil separation from the grease, and uniformity of particle dispersion throughout the grease.

Permeability and Oil Separation

Oil separation from a grease must logically be governed by the permeability of the network and the viscosity of the oil. Low leakage results from a combination of low permeability and high viscosity.

Permeability and oil separation were determined for four commercial lithium greases made with oils of different viscosity. Data for these greases are presented in Table I, together with the ratios of permeability to oil viscosity. Oil separation was measured by the ASTM test.[1] Permeability and oil separation are not in the same order, as oil separation is also affected by oil viscosity. Oil separation and the ratio of permeability to viscosity are in the same order but are not linearly related. The absence of a linear relationship probably results from the continually changing composition of the grease, as oil leaks out, and the build-up of a thickener-rich layer next to the filter in the ASTM test.

Table I

Permeability and Oil Separation of Lithium Greases

Oil Viscosity, stokes	*Permeability, cm.²*	*Oil Separation, %*	$\frac{B}{\mu}$
1.65	3.0×10^{-11}	1.7	1.8×10^{-11}
1.43	14.5	3.6	10
4.44	54.1	12	12
2.13	39.6	>20	19

The ASTM test cannot be used to measure the oil separation of soft or semifluid greases because they would be extruded through the screen used. However, the permeabilities and oil viscosities of such greases can be measured. Hence, the oil separation of such a grease can be estimated by extrapolating a plot of oil separation against the ratio B/μ.

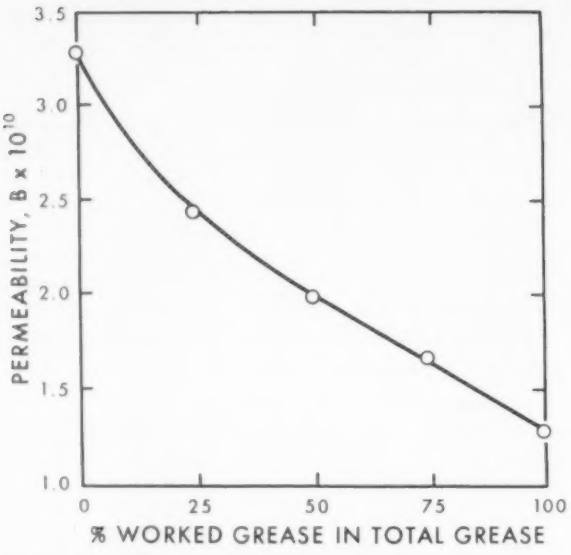


FIGURE 4—Permeability of rheopectic greases.

Permeability and Dispersion

Although the particle dimensions in a lubricating grease can be measured with the electron microscope, there is no way to determine how homogeneously dispersed the particles are. Because permeability is determined by the size and number of passages in a porous material, it offers a means for estimating particle dispersion.

Permeability was related to dispersion by measuring the permeabilities of lithium greases having the same thickener concentration but different degrees of dispersion. The greases were prepared by blending worked and unworked portions of a rheopectic grease. The unworked grease is a fluid material containing clumps of undispersed thickener. Working the grease, as by passing it through a capillary, disperses the thickener and increases consistency. Permeability is shown in Figure 4 as a function of the proportion of worked and unworked grease. The unworked grease is 2.5 times more permeable than the worked grease. The deviation of the curve from linearity indicates that blending of the worked and unworked greases increased the dispersion. In the unworked grease, oil tends to flow around rather than through the clumps of undispersed thickener. As dispersion increases, the clumps of thickener are broken up and permeability decreases.

Conclusion

These exploratory studies of permeability break ground for the use of a new property as a valuable tool in the development of better lubricating greases. Much remains to be done to fully explore the usefulness of permeability in grease research. The validity of Darcy's law, as applied to greases, needs to be firmly established. The law predicts such linear plots as Figure 3, but it should be further tested by varying sample thickness and oil viscosity. How permeability changes with thickener concentration and with phase changes in crystalline thickeners should also be studied.

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A. W. Sisko *graduated from Syracuse university with an AB degree in chemistry in* 1942. *He received his PhD in physical chemistry from Case Institute of Technology in* 1956. *He is now senior project chemist in the research and development department of American Oil Co., Whiting, Ind. Dr. Sisko is a member of the Society of Rheology, Sigma Xi and ACS. He has contributed to the* NLGI Spokesman *previously.*

About the Authors

L. C. Brunstrum *has been a member of the research department of the American Oil Co. since he received a BS degree in chemical engineering from Armour Institute of Technology in* 1929. *He is now senior research associate in the research and development department. Active in ASTM, he is a member of ACS, the Society of Rheology and ASLE. A frequent contributor to the* Spokesman, *Mr. Brunstrum is serving his second term as chairman of the NLGI Technical Committee. In* 1958, *he was the seventh man to be honored by the "Award of Achievement," after five years as Technical Committee vice-chairman and numerous contributions to the industry.*

Literature and Patent Abstracts

Composition

Silica Thickened Lubricating Greases

Milberger in U.S. Patent 2,961,-402, assigned to the Standard Oil Co., Ohio, suggests the use of a carbinoxyaminosilane to confer water-repellency on silica thickened lubricating greases. The preferred additive is a dialkoxydiaminosilane used in a proportion of 0.2 to 2 per cent by weight of the lubricant.

For example, a lubricating grease was made from 89 weight per cent of 300 red oil, 10 weight per cent of Santocel C, and 1 weight per cent of Sylon RD 602 (di-tert-butoxydiaminosilane). The Sylon was dissolved in the oil, after which the silica was mixed in. After mixing for twenty minutes, the lubricant was allowed to age for seventeen hours. When a stainless steel plate was coated with this lubricating grease and immersed in a beaker of water overnight, the coating was unaffected. In boiling water the coating broke down in 29 minutes, whereas a calcium base wheel bearing grease decomposed in 18 minutes.

Zinc Mercaptides as Thickeners For Lubricating Greases

According to Millikan and Fronczak (U.S. Patent 2,963,434, assigned to the Pure Oil Co.) metal mercaptides, and particularly the zinc salt, are suitable for thickening lubricating fluids to a grease consistency. Such bodying agents are formed by reacting zinc oxide with aliphatic, straight-chain mercaptans, in which the alkyl group has from eight to eighteen carbon atoms per molecule. The reaction is carried out in a solution of a liquid nitrogenous base, such as liquid ammonia, ethylamine or propylamine.

For example, 12.2 grams of zinc oxide were added to 250 ml. of liquid ammonia with stirring. Then a mixture of 40.5 grams of 1-dodecyl mercaptan, 50 ml. of toluene and 50 ml. of 85 at 100°F 100 V.I. oil was slowly added as stirring continued. As the ammonia evaporated at room temperature, the mixture became gelatinous, and 300 ml. of toluene were added. Heating and stirring over steam for an hour reduced the system to a liquid phase which was vacuum filtered to remove excess zinc oxide. Finally, the toluene was removed by nitrogen stripping over steam. The resulting

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bearing or rides on a shaft if it slides
in a groove or moves on a pivot if
it bores or cuts or transmits pressure
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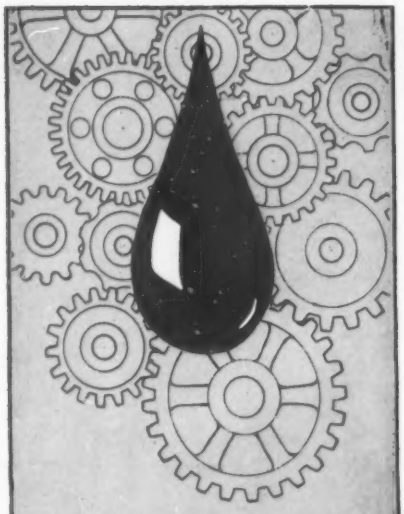

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product contained 8.0 per cent zinc and 7.2 per cent sulfur corresponding to approximately 55 per cent zinc mercaptide.

A mixture was made of 11 grams of this zinc mercaptide concentrate, 9 grams of the 85 viscosity neutral, 53.5 grams of a 200 at 100°F neutral of 90 V.I., and 26.5 grams of a 160 at 210°F bright stock. The mixture was heated to 110°C with stirring and then poured into a shallow pan to cool. After cooling, the mass was passed through a colloid mill to give a final lubricating grease having a consistency between a No. 0 and No. 1 grade and a 200°F dropping point.

Lubricating Grease Thickeners Consisting of Mixtures of Fine Silica And Pyrogenic Alumina

Marsden and Berstein in U.S. Patent 2,965,568 describe the use of mixtures of fine silica and pyrogenic alumina as thickeners for lubricating greases. The advantages of the use of the mixture rest in the fact that the lubricant is both more shear stable and more water resistant than if the silica alone were used. The pyrogenic alumina, which has a particle size of 10 to 40 millimicrons, is obtained by flame oxidation of a finely dispersed aluminum salt.

Comparison of two lubricating greases, in which the fluid is a high V.I. oil, is made. The first contained 7 per cent of fine silica and had a worked penetration of 284 which changed to 307 after 5000 strokes in a grease worker. The other product also contained 7 per cent of thickener but 60 per cent of this was fine alumina and 40 per cent fine silica. This formed a lubricating grease which had a worked penetration of 342 and changed by 11 points after 5000 strokes. The first lubricant disintegrated in less than three seconds in boiling water, whereas the second mixture was not disintegrated after 50 minutes boiling. The same water resistance prevailed after the last lubricating grease had been heated to 300°F for 24 hours followed by cooling to room temperature.

Rust-Preventive Clay-Thickened Lubricating Greases

In U.S. Patent 2,963,436, assigned to Phillips Petroleum Co., Stratton describes the use of orthophosphite salts in clay-thickened lubricating greases to impart rust-inhibiting qualities. The salts are those of ammonium or of alkali metals. The preferred concentrations of the additive are 0.2 to 2 per cent by weight of the finished lubricant.

As a matter of comparison, lots of lubricating grease were made with and without the inhibitor. In one case 5.5 per cent of Bentone 34, 93.75 per cent of a solvent refined SAE 20 oil and 0.75 per cent of aceto-nitrile were used. This product, which had a worked penetration of 289 when used as a coating on steel panels and exposed in a humidity cabinet, permitted 70 to 85 per cent of the panel to rust in 96 hours. The other product contained 5.5 per cent Bentone 34, 91.7 per cent of the SAE 20 oil, 0.8 per cent aceto-nitrile and 2.0 per cent of a 35 per cent solution of sodium orthophosphite. In the humidity cabinet test, using the latter lubricating grease, 2 to 3 per cent of the panel surfaces rusted. During the grease formation, the phosphite solution was added after a pre-gel had formed and before milling.

Antifriction Bearing Lubricating Grease

A method of improving the high temperature operation of certain lubricating greases in antifriction bearings is described by Ambrose and McCarthy in U.S. Patent 2,966,-461, assigned to Gulf Research and Development Co. The products to which the suggestion is applicable are those in which the thickener is a sodium, lithium, barium or strontium soap but not those thickened with aluminum or calcium soaps or with inorganic materials.

If five to 30 per cent of certain detergent additives is added to lubricating greases containing the first series of soaps, the performance of the products in antifriction bearings operating at temperatures above

200°F is improved. The additives are selected from any of four groups or mixtures of the same. One group consists of a mixture of barium or calcium sulfonated of an alkylated aromatic hydrocarbon in which the alkyl groups contain a total of 8 to 100 carbon atoms, such as barium nonyl benzene sulfonate or calcium octyl benzene sulfonate, and basic or neutral salts of phenol sulfides, such as barium tert-octyl phenol sulfide. The second group is a mixture of the sulfides above which have been treated with phosphorus pentasulfide and of the sulfonates mentioned above. The third group consists of products obtained by reacting a terpene hydrocarbon with phosphorus pentasulfide. The final group is a mixture of the last reaction product mentioned and barium or calcium sulfonates of an alkylated aromatic hydrocarbon.

After a lubricating grease is made by a normal procedure from natural fats or fatty acids, it is cooled to 200°F where the additive is mixed in before milling the product.

For example, a lubricating grease, containing 68.65 per cent of an oil of 305 SUS at 100°F, 24.67 per cent of commercial stearic acid, 3.92 per cent sodium hydroxide, 1.74 per cent glycerol and 1.02 per cent diphenylamine, was mixed with 7.5 per cent of an additive consisting of the reaction product of phosphorus pentasulfide and a terpene. Before the addition the worked penetration was 222 and the dropping point 443 and when operated in a ball bearing at 250°F, the time to failure was 2,899 hours. After the addition, these values were 180, 372 and 4,194 hours.

Complex Base Lubricating Greases Containing Phosphoric Acid Salts

Morway in U.S. Patent 2,967,151, assigned to Esso Research and Engineering Co., describes lubricating greases having high dropping points and E.P. qualities, which have thickeners formed by neutralizing mixtures of high molecular weight fatty acids, low molecular weight acids and phosphoric acid with an alkaline earth alkali, preferably lime.

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The fatty acids most desirable are those having 18 to 22 carbon atoms per molecule, which may be saturated or unsaturated. Acetic acid is the preferred low molecular weight acid. The mol ratio of the low molecular weight acid to the high should be about 15:1 to 25:1 and of the combined low molecular weight acid plus the phosphoric acid to the high molecular weight acid about 25:1 to 30:1.

Such lubricating greases are formed in a normal manner. For example, 10.9 parts of hydrated lime were slurried with 70.6 parts of a lubricating oil having a viscosity of 55 SUS at 210°F. Next, 3 parts of powdered stearic acid were added to the slurry, immediately followed by a mixture of 12 parts of glacial acetic acid and three parts of 85 per cent strength phosphoric acid. A solid mass formed immediately and the temperature rose to about 190°F. After adding 0.5 parts of phenyl alpha naphthylamine and stirring for two hours, the mass was homogenized.

This gave a lubricating grease having a worked penetration of 250 which changed to 298 after 75,000 strokes. The dropping point was 500°F+ and using the lubricant on a Timken test a pass was obtained at a load of 50 pounds. By heating the mass to 400 to 550°F before adding the low molecular weight acids, products with longer service life result.

Lubricating Greases Containing Phosphonic Acid Salts

According to Esso Research and Engineering Co. in British Patent 852,983, metal salts of certain phosphonic acids not only act as thickeners in lubricating greases but also serve as anti-oxidants and load-carrying components. In addition, the finished products have high dropping points.

The preferred metals are those of the alkali or alkaline earth series with calcium or lithium particularly. Desirable acids include cetane phosphonic acid, dodecane phosphonic acid, ethane phosphonic acid, etc.

The phosphonate may be used as the sole salt component of the lubricant or it may be used in the form of a mixed-salt with a carboxylate or sulfonate. The fatty acids used to form the carboxylate may be low molecular weight, intermediate molecular weight or high molecular weight.

For example, 19.3 grams of cetane phosphonic acid in the form of a finely divided powder were dispersed in 20 grams of water to form a paste which was heated to 210°F. Next, 77.4 grams of a mineral oil having a viscosity of 300 SUS at 100°F and a V.I. of 70 were added slowly with constant stirring. Finally, a water slurry containing 3.3 grams of lithium hydroxide monohydrate and 10 grams of water was added to the oil-phosphonic acid solution to neutralize the acid. The mass was then dehydrated on a hot plate for about one hour at a final temperature of 400°F, cooled to 150°F and milled.

The resulting lubricating grease had a worked penetration of 274, a dropping point above 500°F, and a loss in a bearing held at 250°F for 300 hours of 9.0 per cent.

Modern Trends in Plug Valve Lubricants

A. A. White, *Scientific Lubrication* v. 12, December 1960 pp. 19-20

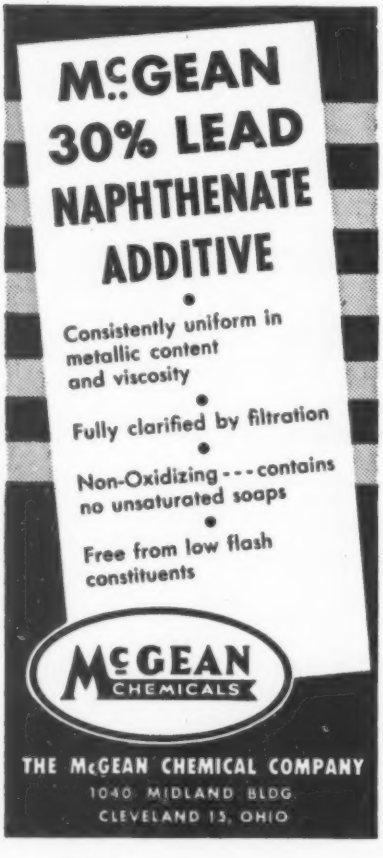
The functions of a plug valve lubricant are said to be to maintain a film between the plug and the valve body so as to permit freedom of operation and yet reduce wear. Also the lubricant must prevent seepage of gas or liquid.

Formerly mineral oil or blown castor oil was blended with either montan or carnauba wax and thickened with aluminum stearate-oleate soap. Such products were suitable for use with hot water, steam, acids and alkalies unless concentrated. More recently Bentones have been employed as thickening agents. Certain polymers and also lithium hydroxystearate are also used in plug valve compositions. Even the complex calcium soaps are employed to some extent.

Composition and Process

Agglomerated Inorganic Gelling Agents for Oils

A process is suggested, by Martinek, Brennan and Fronczak in U.S. Patent 2,960,467, assigned to



the Pure Oil Co., in which inorganic gelling agents are increased in bulk density by agglomeration. The procedure is to mix a fine powdery material, such as silica, with 5 to 30 per cent of a lubricating fluid and then compact this mixture to form small diameter tablets or pellets. The mixing and compacting is facilitated by including 0.001 to 2 per cent of an oil-soluble organic polar dispersant in the composition. The predominate liquid used in the pellet mixtures may be a fatty oil, fatty acids, amines, etc. The polar dispersant may be fatty acids, amines, metal soaps, esters, etc.

Thus Estersil (a fine silica) was wetted with 10 per cent of Ucon LB-550 and the mixture was reduced to about one-third its original volume by compressing in a conventional tableting machine. The tablets were easily breakable, and 10 per cent of these was mixed with a blend of 67.5 per cent 160 bright stock and 22.5 per cent phenol extract of bright stock and processed into a lubricating grease which had a worked penetration of 288 which changed to 279 after heating the mass to 300°F and cooling to 77°F.

Tests

High Temperature Tests of Antifriction Bearing Lubricating Greases

Ambrose and McCarthy in U.S. Patent 2,966,461, assigned to Gulf Research and Development Co., describe a test machine used in evaluating antifriction bearing lubricants.

This apparatus consists of two flat-rimmed steel wheels, each containing two No. 6210 ball bearings, mounted on two parallel spindles, one above the other, and loaded through a system of levers and fulcrum plates by tangential contact of the wheels. The lower spindle with its wheel is connected to the loading system, and the upper assembly is brought to bear upon the lower by turning down two large screws until it counterbalances the chosen loading weight, which in tests described was 1000 pounds. To insure a fixed temperature of 250°F, the wheels are enclosed in an insulated box and heated by thermostatically controlled ring heaters surrounding the hubs. A cartridge heater in the rear of each spindle compensates for the heat loss through the heavy steel structure. Thermocouples are situated in grooves in the spindles and contact each bearing. A pulley on the upper wheel and two appropriate holes in the side of the insulated box provide for a belt driven by means of a motor mounted on the outside.

For a test, ten grams of lubricating grease are packed into each ball bearing. The test run continues as long as the bearings remain lubricated by the original charge, but with several interruptions for inspections. Finally, the run is terminated and the lubricant failure declared when the race paths are found to be dry, a condition sometimes signalized by a sudden temperature rise in the bearing.

Further details of the machine are given in *National Petroleum News*, v. 37, Part 1, January 3, 1945 by Exline and Flesher.

A Method for Accelerating the Federal Test Method Procedure for Determining the Mean Hertz Load. George P. Murphy (Rock Island Arsenal) 8 July 1960, 14p. Report No. 60-2156. Order from LC mi. $2.40 ph. No. 3.30, PB 149,053.

The test procedure is a combination of Girelli's "Compensation Line" and Nason's modification of the Mean Hertz Load procedure. The new test procedure gives Mean Hertz Load values that are on the average within 2 per cent of the values obtained by Federal Test Method 6503. The advantage of the new procedure is that it reduces the number of runs necessary to determine the Mean Hertz Load from 20 to between 2 and 6 depending on the material tested. This is equivalent to a time savings of about 140 to 180 minutes, in addition to the savings in cost of the test specimens. The procedure is applicable to both E.P. and non-E.P. oils and lubricating greases with the exception of those containing silicons.

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october 29—november 1, 1961 rice hotel houston, texas

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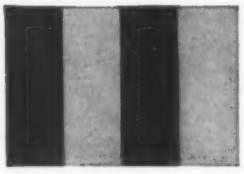
- Planning the modern grease plant
- Building the modern grease plant
- Pilot scale manufacture of lubricating grease
- Rapeseed oil greases
- Marketing of special petroleum products
- New aspects in grease milling
- Complete survey of lubrication needs in the farm trade

and the ASTM-NLGI symposium on fluid gear lubricants . . . an all-day session in itself. Other papers will be announced at a later date.

Special programs for the ladies, not too far from Old Mexico, and the wonderful hospitality of the fabulous Texans can help add up to an annual meeting you won't want to miss.



People in the Industry

J. J. Coates Appointed Manager of Humble's Everett, Mass., Refinery

Effective June 1, J. J. Coates assumed the position of manager of the Humble Oil and Refining company refinery at Everett, Mass. He had been manager of Humble's Pittsburgh grease manufacturing plant since 1958.

After five years of experience with S. T. Powell Associates in Baltimore, Coates joined Esso Standard (now Humble) in 1944, and was at the Baton Rouge refinery in several assignments from then until 1958. He has a B.S. in engineering from Manhattan college in 1936, and an M.C.E. from New York University in 1939.

In 1959, Coates was elected to the NLGI Board of Directors. He is currently chairman of the membership committee and is a member of the executive, publicity and program committees of the Institute.

Newcombe Appointed to New Monsanto Position

J. W. Newcombe of St. Louis, product sales manager for petroleum chemicals and functional fluids with Monsanto Chemical company's organic chemicals division, has been appointed to a newly-created position of petroleum chemicals specialist for that division, effective June 1.

George R. Buchanan of St. Louis, associate product sales manager for petroleum chemicals and functional fluids, has been appointed product sales manager, succeeding Newcombe. He will be responsible for directing the division's sales efforts on oil and gasoline additives and aviation and industrial fluids.

In his new capacity, Newcombe will work closely with automobile and equipment manufacturers and related federal agencies on problems common to the automotive and oil industries and to obtain acceptance and recommendation of Monsanto petroleum chemicals. His activities will relate to research and development as well as to marketing.

Newcombe joined Monsanto in 1944 and has been associated with its petroleum chemicals sales activities since that time. He has been product sales manager for petroleum chemicals since 1947, and is the company's NLGI representative.

Buchanan joined Monsanto in 1945 and served in research and development capacities with its or-

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ganic chemicals division, becoming a section manager with its development department in 1953. He was appointed to his present position in August, 1956.

Lincoln Announces Management Promotions

A series of management promotions for Lincoln Engineering company of St. Louis have been announced by Jonathan Kludt, executive vice-president of McNeil Machine and Engineering company of Akron, Ohio. Lincoln is a division of McNeil with general offices and manufacturing plant in St. Louis.

Carl Mueller, formerly director of engineering, has been appointed general manager. Mueller joined Lincoln in 1930 and managed product development and market research activities prior to 1952 when he became director of engineering.

John Renner, formerly general sales manager, has been appointed general sales manager of the Lincoln division and assistant treasurer of McNeil. Renner joined Lincoln in 1934 and was automotive sales manager from 1946 to 1951 when he became general sales manager. He replaces Foster Holmes, who retired April 30th after 30 years with Lincoln, as assistant treasurer.

Emery Appoints Two To Organic Chemicals Division Technical Staff

Two appointments to the organic chemicals division technical staff of Emery Industries, Inc., have been announced by R. F. Brown, general manager. Kenneth H. Pettengill has been named manager of the process research section, and Herbert M. Kay has been appointed a product development representative for the development-service department.

Pettengill is a past chairman of the Ohio Valley section of the American Institute of Chemical Engineers. He has a chemical engineering degree from the Massachusetts Institute of Technology.

Kay is engaged in market development for new plasticizers. He

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comes to Emery from the position of technical service engineer at Celanese corporation, and holds an M.A. degree from Hofstra college, at which he also took his undergraduate work.

Bijur Names Durnan as Executive Vice-President

William E. Durnan has been named executive vice-president of Bijur Lubricating Corp., according to an announcement from T. R. Thomas, president of the company.

A leader in the field of centralized lubrication systems for all types of equipment, Bijur has been designing and manufacturing lubrication systems for 40 years.

Mr. Durnan joined Bijur as a production engineer in 1941. In 1945 he was appointed production manager, and manufacturing manager in 1949. For the past year, he has served as general manager of the company.

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Industry News

ASLE Elects 1960-61 Officers and Directors

New officers and directors were announced by the American Society of Lubrication Engineers following their annual meeting on April 11-13, 1961, in Philadelphia.

The new president for 1960-61 is Dean M. Cleaveland, Bendix Corp., South Bend, Ind. The vice-president-at-large is L. B. Sargent, Jr., Aluminum Company of America, Pittsburgh, Pa. W. E. Hoch, Viscosity Oil Co., Chicago, Ill., was re-elected treasurer, and A. E. Cichelli, Bethlehem Steel Corp., Bethlehem, Pa., was re-elected secretary. Regional vice-presidents are: J. D. Finnie, Shell Oil Co. of Canada, Ltd., Montreal, Quebec, Canada, and R. F. Connelly, Bray Oil Co., Los Angeles, Calif. New directors for the year are: C. S. Mercer, Morgan Construction Co., Worcester, Mass.; R. K. Gould, Texaco Inc., Beacon, N. Y.; and R. C. Garretson, Westinghouse Electric Corp., Pittsburgh, Pa.

ASLE regional vice-presidents continuing to serve are: M. M. Gurgo (Esso Standard Oil, Div. Humble Oil and Refining, Pittsburgh, Pa.), eastern regional vice-president; J. L. Finkelmann (Chrysler Corp., Trenton, Mich.), central regional vice-president; J. N. Waddell (Henry H. Cross Co., Chicago, Ill.), midwest regional vice-president. The directors continuing to serve are: H. T. Peeples (Timken Roller Bearing Co., Canton, Ohio), S. R. Calish, Jr. (California Research Corp., Richmond, Calif.), E. G. Jackson (National Research Corp., Cambridge, Mass.), L. E. Hoyer (American Brake Shoe Co., Mahwah, N. J.), and A. A. Raimondi (Westinghouse Research Laboratory, Pittsburgh, Pa.).

The organization has appointed a new executive secretary, Donald B. Sanberg. He was formerly with the Malleable Founders Society in Cleveland, Ohio.

NPA Names Olsen A Vice-President

G. A. Olsen, president of Sunland Refining, Fresno, Calif., and a member of NLGI's board of directors, has been made a vice-president of the National Petroleum association. The action came at NPA's recent midyear meeting.

A member of the Institute's governing body since 1952, Olsen was president of NLGI in 1954.

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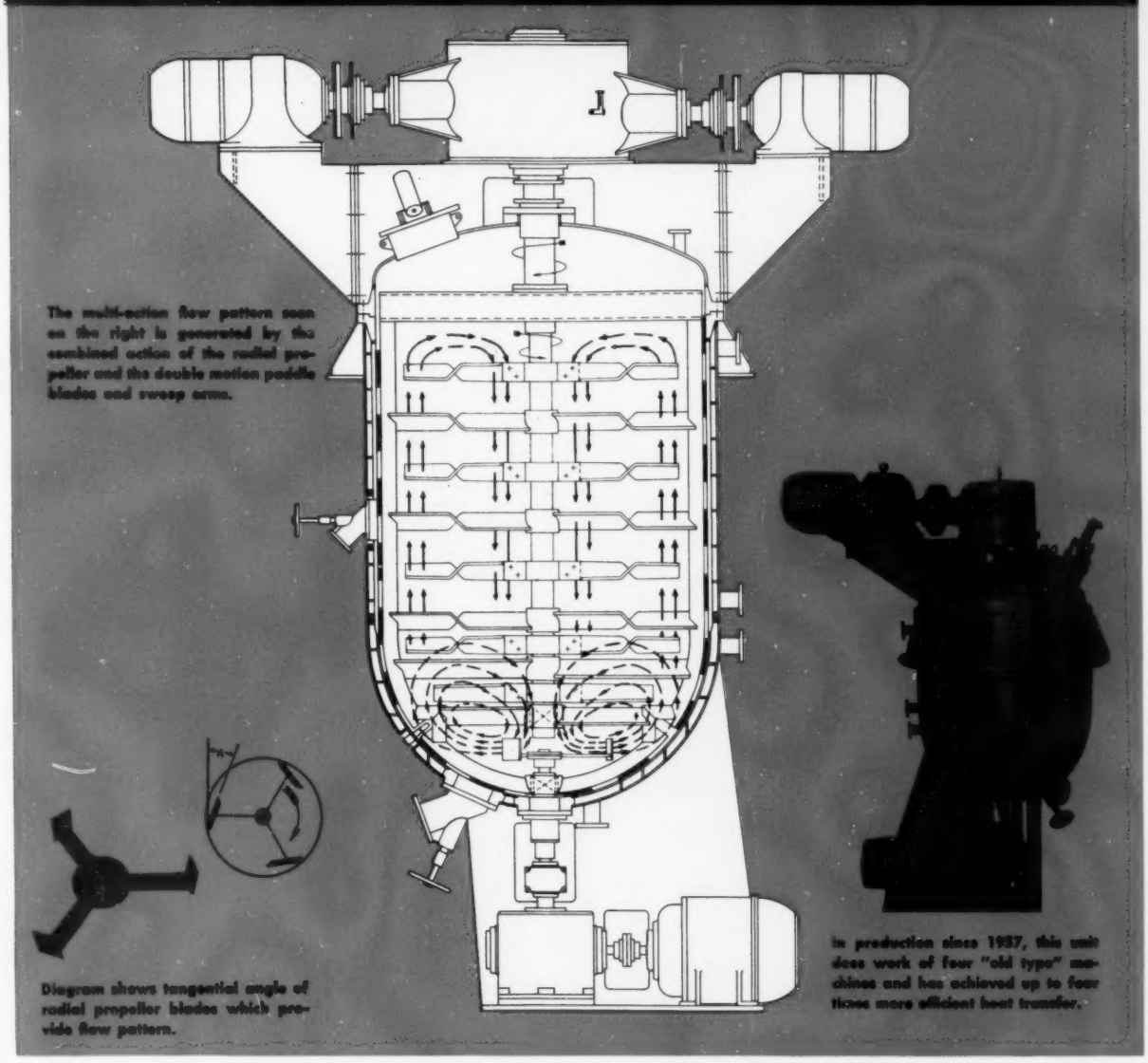

The multi-action flow pattern seen on the right is generated by the combined action of the radial propeller and the double motion paddle blades and sweep arms.

Diagram shows tangential angle of radial propeller blades which provide flow pattern.

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